United Kingdom of Great Britain and Northern Ireland

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BS NA EN 1992-2 (2005) (English): UK National Annex to Eurocode 2. Design of concrete structures. Concrete bridges. Design and detailing rules

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NATIONAL ANNEX

UK National Annex to Eurocode 2: Design of concrete structure

Part 2: Concrete bridges – Design and detailing rules

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National Annex (informative) to BS EN 1992-2:2005, Eurocode 2: Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/2 *Structural use of concrete*. In the UK it is to be used in conjunction with BS EN 1992-2:2005.

NA.1 Scope

This National Annex gives:

a) the UK decisions for the Nationally Determined Parameters described in the following subclauses of BS EN 1992-2:2005:

- **3.1.2** (102)P
- **3.1.6** (101)P
- **3.1.6** (102)P
- **3.2.4** (101)P
- **4.2** (105)
- **4.2** (106)
- **4.4.1.2** (109)
- **5.1.3** (101)P
- **5.2** (105)
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- **5.5** (104)
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- **6.1** (110)
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- **8.9.1** (101)
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- **9.1** (103)
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- **9.5.3** (101)
- **9.7** (102)
- **9.8.1** (103)
- **11.9**
- **113.2** (102)
- **113.3.2** (103)

b) the UK decisions on the status of BS EN 1992-2:2005 informative annexes; and

c) references to non-contradictory complementary information.

NA.2 Nationally determined parameters

NA.2.1 General

UK decisions on the nationally determined parameters described in BS EN 1992-2:2005 are given in Table NA.1 and Table NA.2 (see also **NA.2.2**).

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005**

Subclause	Nationally determined parameter	Eurocode recommendation	UK decision
Foreword	Definition of National Authorities	None given	The body with a statutory responsibility for the safety of the structure.
3.1.2 (102)P	Value of C_{min}	C30/37	C25/30
3.1.2 (102)P	Value of C_{max}	C70/85	C70/85. However the shear strength of concrete classes higher than C50/60 should be determined by tests, unless there is evidence of satisfactory past performance of the particular mix including the type of aggregates used. Alternatively shear strength of concrete strength classes higher than C50/60 may be limited to that of C50/60.
3.1.6 (101)P	Value of α_{cc}	0,85	1,0 except in the following clauses where it should be taken as 0,85: • **3.1.7** • **5.8** • **6.5.2** (1) • **6.5.4** • **6.7** • **8.3** (3) • **8.6** (5) • **10.9.2** (2) • **10.9.4.3** (3) • **10.9.5.2** (1) • **10.9.5.2** (2) • **12.6.1** (3) • **12.6.5.2** (1) • **J.104.1** (103)
3.1.6 (102)P	Value of α_{ct}	1,0	Use the recommended value.
3.2.4 (101)P	Classes of reinforcement to be used in bridges.	Class B and Class C	Class B and Class C. For steel fabric reinforcement, Class A may also be used provided it is not taken into account in the evaluation of the ultimate resistance.
4.2 (105)	Exposure class for a concrete surface protected by waterproofing.	XC3	Use the recommended class.
4.2 (106)	Distance x	6,0 m	10,0 m
4.2 (106)	Distance y	6,0 m	5,0 m

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** *(continued)*

Subclause	**Nationally determined parameter**	**Eurocode recommendation**	**UK decision**
4.2 (106)	Exposure classes for surfaces directly affected by de-icing salts.	XD3 and XF2 or XF4	Use the recommended classes.
4.4.1.2 (109)	Required cover to reinforcement where in-situ concrete is placed against an existing concrete surface.	The cover needs only satisfy the requirements for bond, provided the following conditions are met: • the existing concrete surface has not been subject to an outdoor environment for more than 28 days; • the existing concrete surface is rough; • the strength class of the existing concrete is at least C25/30.	Use the recommended requirement.
5.1.3 (101)P	Simplifications to load arrangements.	None given	No simplifications recommended.
5.2 (105)	Value of θ_0	1/200	Use the recommended value.
5.3.2.2 (104)	Value of t	t = breadth of the bearing	Use the recommended value.
5.5 (104)	Values for k_1, k_2, k_3, k_4 and k_5	$k_1 = 0,44$ $k_2 = 1,25(0,6 + 0,0014/\varepsilon_{cu2})$ $k_3 = 0,54$ $k_4 = 1,25(0,6 + 0,0014/\varepsilon_{cu2})$ $k_5 = 0,85$	Use the recommended values.

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** (*continued*)

Subclause	Nationally determined parameter	Eurocode recommendation	UK decision
5.7 (105)	Details of acceptable methods for non-linear analysis and safety format.	When using non-linear analysis the following assumptions should be made: • For reinforcing steel, the stress-strain diagram to be used should be based on Figure 3.8, curve A. In this diagram, f_{yk} and kf_{yk} should be replaced by $1,1f_{yk}$ and $1,1kf_{yk}$ • For prestressing steel, the idealized stress-strain diagram given in **3.3.6** (Figure 3.10, curve A) should be used. In this diagram f_{pk} should be replaced with $1,1f_{pk}$ • For concrete, the stress-strain diagram should be based on expression (3.14) in **3.1.5**. In this expression, and in the k-value, f_{cm} should be replaced by $\gamma_{cf} \cdot f_{ck}$, with $\gamma_{cf} = 1,1 \cdot \gamma_S / \gamma_C$ The following design format should be used: • The resistance should be evaluated for different levels of appropriate actions which should be increased from their serviceability values by incremental steps, such that the values of $\gamma_G \cdot G_k$ and $\gamma_Q \cdot Q_k$ are reached in the same step. The incrementing process should be continued until one region of the structure attains the ultimate strength, evaluated taking account of α_{cc}, or there is global failure of the structure. The corresponding load is referred to as q_{ud}. • Apply an overall safety factor γ_O and obtain the corresponding strength $R\left(\frac{q_{ud}}{\gamma_O}\right)$. • One of the following inequalities should be satisfied: $\gamma_{Rd} E(\gamma_G G + \gamma_Q Q) \leqslant R\left(\frac{q_{ud}}{\gamma_O}\right)$ or $E(\gamma_G G + \gamma_Q Q) \leqslant R\left(\frac{q_{ud}}{\gamma_{Rd} \cdot \gamma_O}\right)$	Non-linear analysis should be undertaken using model factors and material models which give results that err on the safe side. Typically, this may be achieved by using design material properties and applying design actions. However, in some situations, underestimating stiffness through the use of design properties can lead to unsafe results. Such situations can include cases where indirect actions such as imposed deformations are significant, cases where the failure load is associated with a local brittle failure mode, and cases where the effect of tension stiffening is unfavourable. In such situations, sensitivity analyses should be undertaken to investigate the effect of variations in material properties, including spatial variations, to provide confidence that the results of the analysis do err on the safe side. For non-linear analysis which considers only direct and flexural effects, reference may be made to **5.8.6**. Such analysis should account for the effects of long term loading. Effects not considered directly in the analysis should be considered separately in accordance with Section **6**. Non-linear analysis which determines shear and torsional strength directly has not yet reached a stage where it can be fully codified. Particular analyses may be used when they have been shown by comparison with tests to give reliable results, with the agreement of the National Authority.

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** (*continued*)

Subclause	Nationally determined parameter	Eurocode recommendation	UK decision
		(i.e.) $R\left(\frac{q_{\mathrm{ud}}}{\gamma_{\mathrm{O}'}}\right)$ or $\gamma_{\mathrm{Rd}}\gamma_{\mathrm{Sd}}E\left(\gamma_{\mathrm{g}}G+\gamma_{\mathrm{q}}Q\right) \leqslant R\left(\frac{q_{\mathrm{ud}}}{\gamma_{\mathrm{O}}}\right)$ where: γ_{Rd} is the partial factor for model uncertainty for resistance, γ_{Rd} = 1,06, γ_{Sd} is the partial factor for model uncertainty for action/action effort, γ_{Sd} = 1,15, γ_{O} is the overall safety factor, γ_{O} = 1,20. Refer to Annex PP for further details. When model uncertainties γ_{Rd} and γ_{Sd} are not considered explicitly in the analysis (i.e. $\gamma_{\mathrm{Rd}} = \gamma_{\mathrm{Sd}} = 1$), $\gamma_{\mathrm{O}}' = 1{,}27$ should be used.	
6.1 (109)b	Value of f_{ctx}	f_{ctm}	$f_{\mathrm{ctk,0,05}}$
6.1 (109)	Applicable methods for avoiding brittle failure.	a, b or c	Use any of the recommended applicable methods.
6.1 (110)ii	Value of k_{cm}	2,0	1,0
6.1 (110)iii	Value of k_{p}	1,0	Use the recommended value.
6.2.2 (101)	Values of $C_{\mathrm{Rd,c}}$, $v_{\min}$ and k_1	$C_{\mathrm{Rd,c}} = 0{,}18/\gamma_{\mathrm{c}}$ $v_{\min} = 0{,}035\, k^{3/2} f_{\mathrm{ck}}^{1/2}$ $k_1 = 0{,}15$	In expression (6.2.a) $C_{\mathrm{Rd,c}}$ should be taken as either: i) $0{,}18/\gamma_{\mathrm{c}}$, or ii) $(0{,}18/\gamma_{\mathrm{c}})\cdot(2d/a)$ provided that the shear force V_{Ed} is not multiplied by β [**6.2.2** (6)] and the longitudinal reinforcement is fully anchored at the support, where a is the distance from the edge of the support (or centre of bearing where flexible bearings are used) to the position at which the shear resistance is considered. In other cases $C_{\mathrm{Rd,c}}$ should be taken as $0{,}18/\gamma_{\mathrm{c}}$.

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** (*continued*)

Subclause	**Nationally determined parameter**	**Eurocode recommendation**	**UK decision**
			Use the recommended values for v_{min} and k_1. See also **3.1.2** (102)P for recommendations for concrete class >C50/60.
6.2.3 (103)	Values of ν_1 and α_{cw}	$\nu_1 = \nu$ However, if the design stress of the shear reinforcement is below 80% of the characteristic yield stress f_{yk}, ν_1 may be taken as: $\nu_1 = 0{,}6$ for $f_{ck} \leqslant 60$ MPa $\nu_1 = 0{,}9 - f_{ck}/200 > 0{,}5$ for $f_{ck} \geqslant 60$ MPa α_{cw} is as follows: 1 for non-prestressed structures $(1 + \sigma_{cp}/f_{cd})$ for $0 < \sigma_{cp} \leqslant 0{,}25 f_{cd}$ 1,25 for $0{,}25 f_{cd} < \sigma_{cp} \leqslant 0{,}5 f_{cd}$ $2{,}5\ (1 - \sigma_{cp}/f_{cd})$ for $0{,}5 f_{cd} < \sigma_{cp} < 1{,}0 f_{cd}$ where: σ_{cp} is the mean compressive stress, measured positive, in the concrete due to the design axial force. This should be obtained by averaging it over the concrete section taking account of the reinforcement. The value of σ_{cp} need not be calculated at a distance less than $0.5d \cot \theta$ from the edge of the support. In the case of straight tendons, a high level of prestress ($\sigma_{cp}/f_{cd} > 0{,}5$) and thin webs, if the tension and the compression chords are able to carry the whole prestressing force and blocks are provided at the extremity of beams to disperse the prestressing force (see fig. 6.101), it may be assumed that the prestressing force is distributed between the chords. In these circumstances, the compression field due to shear only should be considered in the web ($\alpha_{cw} = 1$).	$\nu_1 = \nu(1 - 0{,}5 \cos \alpha)$ However, if the design stress of the shear reinforcement is below 80% of the characteristic yield stress f_{yk}, ν_1 may be taken as: $\nu_1 = 0{,}54\ (1 - 0{,}5 \cos \alpha)$ for $f_{ck} \leqslant 60$ MPa $\nu_1 = (0{,}84 - f_{ck}/200)\ (1 - 0{,}5 \cos \alpha) > 0{,}5$ for $f_{ck} \geqslant 60$ MPa α_{cw} is as follows: 1 for non-prestressed structures $(1 + \sigma_{cp}/f_{cd})$ for $0 < \sigma_{cp} \leqslant 0{,}25 f_{cd}$ 1,25 for $0{,}25 f_{cd} < \sigma_{cp} \leqslant 0{,}5 f_{cd}$ $2{,}5\ (1 - \sigma_{cp}/f_{cd})$ for $0{,}5 f_{cd} < \sigma_{cp} < 1{,}0 f_{cd}$ where: σ_{cp} is the mean compressive stress, measured positive, in the concrete due to the design axial force. This should be obtained by averaging it over the concrete section taking account of the reinforcement. The value of σ_{cp} need not be calculated at a distance less than $0.5d \cot \theta$ from the edge of the support. *NOTE The values of ν_1 and α_{cw} should not give rise to a value of $V_{Rd,max}$ greater than $200 b_w^2$ at sections more than a distance d from the edge of a support. For this purpose, the value of b_w does not need to be reduced for ducts.* In the case of straight tendons, a high level of prestress ($\sigma_{cp}/f_{cd} > 0{,}5$) and thin webs, if the tension and the compression chords are able to carry the whole prestressing force and blocks are provided at the extremity of beams to disperse the prestressing force (see fig. 6.101), it may be assumed that the prestressing force is distributed between the chords. In these circumstances, the compression field due to shear only should be considered in the web ($\alpha_{cw} = 1$). See also **3.1.2** (102)P for recommendations for concrete class >C50/60.

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** (*continued*)

Subclause	Nationally determined parameter	Eurocode recommendation	UK decision
6.2.3 (107)	Guidance on the superposition of different truss models.	In the case of bonded prestressing, located within the tensile chord, the resisting effect of prestressing may be taken into account for carrying the total longitudinal tensile force. In the case of inclined bonded prestressing tendons in combination with other longitudinal reinforcement/tendons the shear strength may be evaluated, by a simplification, superimposing two different truss models with different geometry (Figure 6.102N); a weighted mean value between θ_1 and θ_2 may be used for concrete stress field verification with Expression (6.9).	Use the recommended guidance.
6.2.3 (109)	Absolute minimum value of h_{red}.	Absolute minimum value of $h_{red} = 0{,}5h$	Use the recommended value.
6.8.1 (102)	Structures and structural elements for which fatigue verification is generally not necessary.	A fatigue verification is generally not necessary for the following structures and structural elements: a) footbridges, with the exception of structural components very sensitive to wind action; b) buried arch and frame structures with a minimum earth cover of 1,00 m and 1,50 m respectively for road and railway bridges; c) foundations; d) piers and columns which are not rigidly connected to superstructures; e) retaining walls of embankments for roads and railways; f) abutments of road and railway bridges which are not rigidly connected to superstructures, except the slabs of hollow abutments; g) prestressing and reinforcing steel, in regions where, under the frequent combination of actions and P_k only compressive stresses occur at the extreme concrete fibres.	Additional rules. Fatigue verification for road bridges is not necessary for the local effects of wheel loads applied directly to a slab spanning between beams or webs provided that: a) the slab does not contain welded reinforcement, or reinforcement couplers; b) the clear span to overall depth ratio of the slab does not exceed 18; c) the slab acts compositely with its supporting beams or webs; d) either: i) the slab also acts compositely with transverse diaphragms; or ii) the width of the slab perpendicular to its span exceeds three times its clear span.
6.8.7 (101)	Value of k_1.	$k_1 = 0{,}85$	Use the recommended value.
7.2 (102)	Value of k_1.	$k_1 = 0{,}6$	Use the recommended value.
7.2 (102)	Maximum increase in stress limit above $k_1 f_{ck}$.	10%	Use the recommended value.

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** *(continued)*

<table>
<tr><th>Subclause</th><th>Nationally determined parameter</th><th>Eurocode recommendation</th><th>UK decision</th></tr>
<tr><td>7.3.1 (105)</td><td>Value of w_{max}, definition of decompression and its application.</td><td>Refer to Table 7.101N.</td><td>Refer to NA.2.2 and Table NA.2</td></tr>
<tr><td>7.3.3 (101)</td><td>Details of a simplified method for control of cracking without calculation.</td><td>The recommended method is that given in EN 1992-1-1, 7.3.3 (2) to (4).</td><td>The recommended method given in BS EN 1992-1-1:2004, 7.3.3 (2) to (4) should be used; however account should also be taken of the effects of restrained thermal and shrinkage strains.</td></tr>
<tr><td>7.3.4 (101)</td><td>Method of calculating crack width</td><td>The recommended method is that given in EN 1992-1-1, 7.3.4</td><td>The recommended method given in BS EN 1992-1-1:2004, 7.3.4 should be used; however account should also be taken of the effects of restrained thermal and shrinkage strains.
The value of c used for the calculation of crack width should be taken as c_{nom}.</td></tr>
<tr><td>8.9.1 (101)</td><td>Restrictions on the use of bundled bars.</td><td>No additional restrictions recommended.</td><td>No additional restrictions recommended.</td></tr>
<tr><td>8.10.4 (105)</td><td>Value of X and the maximum percentage of tendons coupled at a section.</td><td>50% and 67% respectively.</td><td>Use the recommended values.</td></tr>
<tr><td>8.10.4 (105)</td><td>Distance a</td><td><table><tr><th>Construction depth, h</th><th>Distance, a</th></tr><tr><td>$\leqslant$ 1,5 m</td><td>1,5 m</td></tr><tr><td>1,5 m $< h <$ 3,0 m</td><td>$a = h$</td></tr><tr><td>$\geqslant$ 3,0 m</td><td>3,0 m</td></tr></table></td><td>Use the recommended values.</td></tr>
<tr><td>8.10.4 (107)</td><td>Additional rules relating to the provision of openings and pockets on the upper side of carriageway slabs.</td><td>No additional rules recommended.</td><td>No additional rules recommended.</td></tr>
<tr><td>9.1 (103)</td><td>Additional rules concerning minimum thickness of structural elements and minimum reinforcement.</td><td>No additional rules recommended.</td><td>No additional rules recommended.</td></tr>
</table>

Table NA.1 **UK decisions for nationally determined parameters in BS EN 1992-2:2005** (*continued*)

Subclause	Nationally determined parameter	Eurocode recommendation	UK decision
9.2.2 (101)	Permitted forms of shear reinforcement.	The recommended forms of shear reinforcement are: • links enclosing the longitudinal tension reinforcement and the compression zone (see Figure 9.5 of EN 1992-1-1); • bent-up bars; • or a combination of the two.	Use the recommended forms.
9.5.3 (101)	Minimum diameter of transverse reinforcement in a column	ϕ_{min} = 6 mm $\phi_{min,mesh}$ = 5 mm	Use the recommended values.
9.7 (102)	Maximum spacing of bars in the faces of beams.	s_{mesh} is the lesser of the web thickness or 300 mm.	Use the recommended value.
9.8.1 (103)	Minimum bar diameter for main tensile reinforcement in pile caps.	d_{min} = 12 mm	Use the recommended value.
11.9 (101)	Additional restrictions on the use of bundled bars in lightweight aggregate concrete.	No additional restrictions recommended.	No additional restrictions recommended.
113.2 (102)	Minimum unbalanced uplift or horizontal wind pressure at execution stage for ULS verification of structural equilibrium for segmental bridges built by balanced cantilever	x = 200 N/m^2	x = calculated ULS value of unbalanced vertical or horizontal wind pressure at execution stage, subject to a minimum of 200 N/m^2.
113.3.2 (103)	Value of k	k = 1,0	Use the recommended value.

NA.2.2 Recommended values of w_{max}, definition of decompression and its application

The value of w_{max} is given in Table NA.2. The decompression limit requires that all concrete within a certain distance of bonded tendons or their ducts should remain in compression under the specified loading. The distance within which all concrete should remain in compression should be taken as the value of $c_{min,dur}$. Where the most tensile face of a section is not subject to XD or XS exposure but another face is, the decompression limit should require all tendons within 100 mm of a surface subject to XD or XS exposure to have a depth $c_{min,dur}$ of concrete in compression between them and surfaces subject to XD or XS exposure.

Table NA.2 **Recommended values of w_{max} and relevant combination rules**

Exposure class A)	**Reinforced members and prestressed members without bonded tendons**	**Prestressed members with bonded tendons**
	Quasi-permanent load combination B) mm	**Frequent load combination** B) mm
X0, XC1	0,3 C)	0,2
XC2, XC3, XC4	0,3	0,2 D)
XD1, XD2, XD3 XS1, XS2, XS3	0,3	0,2 E) and decompression

A) The exposure class considered, including at transfer, applies to the most severe exposure the surface will be subject to in service.

B) For the crack width checks under combinations which include temperature distribution, the resulting member forces should be calculated using gross section concrete properties and self-equilibrating thermal stresses within a section may be ignored.

C) For X0, XC1 exposure classes, crack width has no influence on durability and this limit is set to guarantee acceptable appearance. In the absence of appearance conditions this limit may be relaxed.

D) For these exposure classes, in addition, decompression should be checked under the quasi-permanent combination of loads.

E) 0,2 applies to the parts of the member that do not have to be checked for decompression.

NA.3 Decisions on the status of informative annexes

*COMMENTARY ON **NA.3***
The informative annexes of EN 1992-2 call for the application of the corresponding informative annexes of EN 1992-1-1, wholly, in part and/or with modifications. The following text therefore gives decisions on the status of informative annexes of 1992-1-1 for use with BS EN 1992-2, where applicable.

BS EN 1992-1-1:2004, informative Annexes A, D and G, as called up in BS EN 1992-2:2005, informative Annexes A, D and G respectively, may be used.

BS EN 1992-2:2005, informative Annexes B and PP are not applicable.

BS EN 1992-1-1:2004, informative Annex B, as called up in BS EN 1992-2:2005, informative Annex B may be used.

BS EN 1992-2:2005, informative Annex E (and by implication BS EN 1992-1-1: 2004, informative Annex E) is not applicable.

BS EN 1992-1-1:2004, informative Annex F, as modified/extended by BS EN 1992-2:2005, may be used, subject to the following amendments:

Delete	"The optimum reinforcement, corresponding to $\theta = 45°$, is indicated by superscript $'$, and related concrete stress are determined by:"
and replace with	"The optimum reinforcement, corresponding to $\theta = 45°$ in (F.2), (F.3) and (F.4), is indicated by superscript $'$, and related concrete stress are determined by:"
Delete	"where θ is the angle of the principal concrete compressive stress to the x-axis."
and replace with	"where θ is the angle of the plastic compression field to the x-axis."

BS EN 1992-1-1:2004, informative Annex H is not applicable, as stated in BS EN 1992-2:2005 informative Annex H.

BS EN 1992-1-1:2004, informative Annex I, as modified by BS EN 1992-2:2005, may be used.

PD 6687:2006[1], informative Annex B (which is the UK replacement for BS EN 1992-1-1:2004, informative Annex J), as extended by BS EN 1992-2:2005, informative Annex J, may be used.

*NOTE In EN 1992-2:2005, **J.104.2** (101) and (104) there are references to 8.10.3 of EN 1992-1-1 and 8.10.3 (4) of EN 1992-1-1, respectively. These references are incorrect and should read 8.10.3 of EN 1992-2 and 8.10.3 (104) of EN 1992-2, respectively.*

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[1] This Published Document is being revised and is to be renumbered PD 6687-1. It is anticipated that informative Annex B will remain unchanged in the revised document.

BS EN 1992-2:2005 informative Annex KK may be used, subject to the following amendment:

Delete **KK.7** and replace with the following:

(101) Forces at time t_∞ may be calculated for those structures that undergo changes in support conditions (span-to-span construction, free cantilever construction, movements at supports, etc.) using a simplified approach. The effects of creep redistribution at time t_∞ may be represented, as a first approximation, by a change in internal force distribution occurring after the construction process equal to:

$$\Delta S_\infty = (S_c - S_0)\frac{\varphi(\infty,t_0) - \varphi(t_c,t_0)}{1 + \chi\varphi(\infty,t_c)} \qquad \text{(K.119)}$$

where:

S_0 is the value of the internal actions obtained from the construction sequence build up. For prestressed bridges, the loss of prestress considered should be taken equal to that at the time of the change to the structural system;

S_c is the value of the internal actions obtained assuming that the whole structure is built in one go. For prestressed bridges, the loss of prestress considered should be taken equal to that at the time of the change to the structural system;

t_0 is the concrete age on application of the load;

t_c is the age of the concrete when the support conditions are changed.

The final force distribution, S_∞, should be derived by adding the redistribution effects from (KK.119) to the forces derived from the construction sequence build up at time t_∞, $S_{0,\infty}$, in accordance with (KK.120). For prestressed structures, $S_{0,\infty}$ should include all long term losses of prestress, based on the force distribution derived from following the construction sequence, but ignoring the effects of creep redistribution.

$$S_\infty = S_{0,\infty} + \Delta S_\infty \qquad \text{(KK.120)}$$

BS EN 1992-2:2005, informative Annex LL may be used subject to the following amendments:

In expression (LL.101), "f_{cm}" is replaced by "f_{cd}".

In expression (LL.112), "f_{cm}" is replaced by "f_{cd}", and "f_{ctm}" is replaced by "f_{ctd}".

Equation (LL.123) is deleted and replaced with "$\rho_1 = \rho_x \cos^4 \varphi_0 + \rho_y \sin^4 \varphi_0$"

Delete clause LL.112 and replace with the following:

(112) The outer layers should be designed as membrane elements. The design rules of Clause **6.109** and Annex F or an alternative realistic membrane element should be used.

BS EN 1992-2:2005 informative Annexes MM, NN, OO and QQ may be used.

NA.4 References to non-contradictory complementary information

The following is a list of references that contain non-contradictory complementary information for use with BS EN 1992-2:2005.

PD 6687:2006, *Background paper to the UK National Annexes to BS EN 1992-1* [2)]

PD 6687-2, *Background paper to the UK National Annex to BS EN 1992-2* [3)]

[2)] This Published Document is being revised and is to be renumbered PD 6687-1.

[3)] In preparation.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 1992-1-1:2004, *Eurocode 2: Design of concrete structures – Part 1: General rules and rules for buildings*

PD 6687:2006, *Background paper to the UK National Annexes to BS EN 1992-1* [4)]

PD 6687-2, *Background paper to the UK National Annex to BS EN 1992-2* [5)]

[4)] This Published Document is being revised and is to be renumbered PD 6687-1.

[5)] In preparation.

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